# PHYTOTOXICOLOGY 1996

# ASSESSMENT INVESTIGATION:

# ABITIBI CONSOLIDATED

# FORT FRANCIS

MAY 1998

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PIBS 3637E

**Phytotoxicology 1996 Assessment Investigation:**
**Abitibi Consolidated - Fort Frances.**

**SDB-013-3511-97**

## Introduction

The ThunderBay District office of the Ministry of Environment and Energy (MOEE) office requested the Phytotoxicology Section, Standards Development Branch, MOEE conduct a terrestrial effects vegetation investigation in the vicinity of the Abitibi Consolidated, formerly Stone Consolidated and Boise Cascade, bleached kraft pulp mill in Fort Frances during the 1996 growing season.

During the first years of operations, emissions from the mill resulted in particulate fallout and odour problems in a nearby residential area. In the late 1970s, some emission reductions were achieved. In 1980, a Control Order was issued for further pollution controls. The mill also created a "buffer zone" through purchase of adjacent residential land.

Since 1972, terrestrial effects vegetation studies have been conducted regularly as part of air quality studies conducted in Fort Frances. Periodically since 1974 these studies have included a similar plant on the US side of the border (1,2,3).

## Investigation

On August 13 and 14, 1996, Randall Jones and William McIlveen of the Phytotoxicology Section, and Don Racette of the Northern Region conducted a vegetation investigation in the vicinity of Abitibi Consolidated, Fort Frances. Duplicate Manitoba maple foliage samples where collected at 19 stations, 17 in Fort Frances, Ontario and two in International Falls, Minnesota (see Figure 1). Standard Phytotoxicology Section sampling procedures (4) where used during the investigation. As the foliage was being analysed for sodium and chloride, the investigators wore plastic protective coverings on their hands to avoid possible sample contamination from sweat.

The samples were transported to the Phytotoxicology Sample Process Laboratory where they were dried and ground. The processed samples were submitted to the Laboratory Services Branch for analysis of sodium, chlorine, and sulphur.

In addition to the samples collected for chemical analysis, visual observations were recorded of the conditions of the trees sampled and any injury observed on the tree leaves.

## Results

The results of the chemical analysis of the Manitoba maple foliage for sodium and chlorine are given in Tables 1 and 2 respectively. The 1996 results for each station are the mean of the duplicate samples and are expressed in either µg/g dry weight, or percentage dry weight. Stations 26, and 27 are considered control locations. For comparison purposes, the results from the 1980, 1992, 1993, 1994, and 1995 investigations are given in each table. The average sodium concentrations for stations 1 to 6, and 9 to 28, excluding the controls and sites in International Falls, from the six investigations are graphed in Figure 2. Similarly, the average chlorine concentrations for stations 1 to 6, and 9 to 28, excluding the controls and sites in International Falls, from the six investigations are graphed in Figure 3.

The visual observations of tree condition, and leaf injury are given in Table 3. Due to the severe hail storm on the morning of August 13, all of the trees suffered from hail damage to the leaves, with up to 50% of the leaves knocked off at some locations. This complicated, but did not invalidate, the visual assessment.

## Discussion

There was a pattern of marginally elevated concentrations of sodium in Manitoba maple foliage in the buffer zone immediately north and east of the Abitibi Consolidated kraft pulp mill. The six stations, 1 to 6, in this zone ranged from 35 to 150 µg/gm dry weight, with an average value of 85 µg/gm. The rest of the sampling stations in Fort Frances averaged 28 µg/gm, which was approximately twice the concentration of the two controls,Stations 26 and 27. All results were well below the Urban Upper Limits of Normal for sodium in vegetation (see Appendix). The sodium concentrations in 1996 are similar to what has been reported in the four previous investigations, 1992 to 1995, and are significantly below the concentrations found in 1980, see figure 2. Phytotoxicology ULN guidelines for sodium in vegetation have not been exceeded at the same sites in the last five investigations.

There was no pattern of decreasing chlorine concentration in Manitoba maple foliage with increasing distance from the plup mill. While there were some elevated levels near the plant, specifically Stations 2 and 5, other nearby stations, for example 1 and 6, where comparable the control stations. There was no correlation between the concentrations of sodium and chlorine. The chlorine concentrations in 1996 are similar to what has been reported in the four previous investigations, 1992 to 1995, and are significantly below the concentrations found in 1980 (see Figure 3).

All of the visible injury observed on the Manitoba maple trees sampled for this investigation could be attributed to insects, physiological stress, and maturity of the trees. There was no evidence of injury related to air pollution.

## Conclusions

The Abitibi Consolidated bleached kraft pulp mill in Fort Frances continues to be a minor source of sodium emissions resulting in marginally elevated concentrations in Manitoba maple foliage in the buffer zone to the immediate north and east of the mill. No evidence of elevated chlorine concentrations were found in Manitoba maple foliage. Naturally higher and more variable concentrations of chlorine found in vegetation may mask out any marginal increase in levels that may result from emissions from the company, making data interpretation more difficult for this element. On average, the concentrations of both chlorine and sodium in Manitoba maple foliage were the lowest of the last five surveys conducted around the mill and are well below the values found in the 1970s and early 1980s.

## References


1. Griffin, D. and D. Racette, Air Quality Northwestern Ontario Anual Report 1991, Ontario Ministry of Environment, Northwest Region, PIBS 2108, 1992.

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3. Griffin, D., D. Racette, and R. Clara, Air Quality Northwestern Ontario Anual Report 1991, Ontario Ministry of Environmentand Energy, Northern Ontario Region, PIBS 3200E01, 1996.

4. McIlveen, W.D. and D.L. McLaughlin, Field Investigation Manual Part 1 - General Methodology, Ontario Ministry of Environment and Energy, Phytotoxicology Section, Report No. 014-3511-93, 1993.

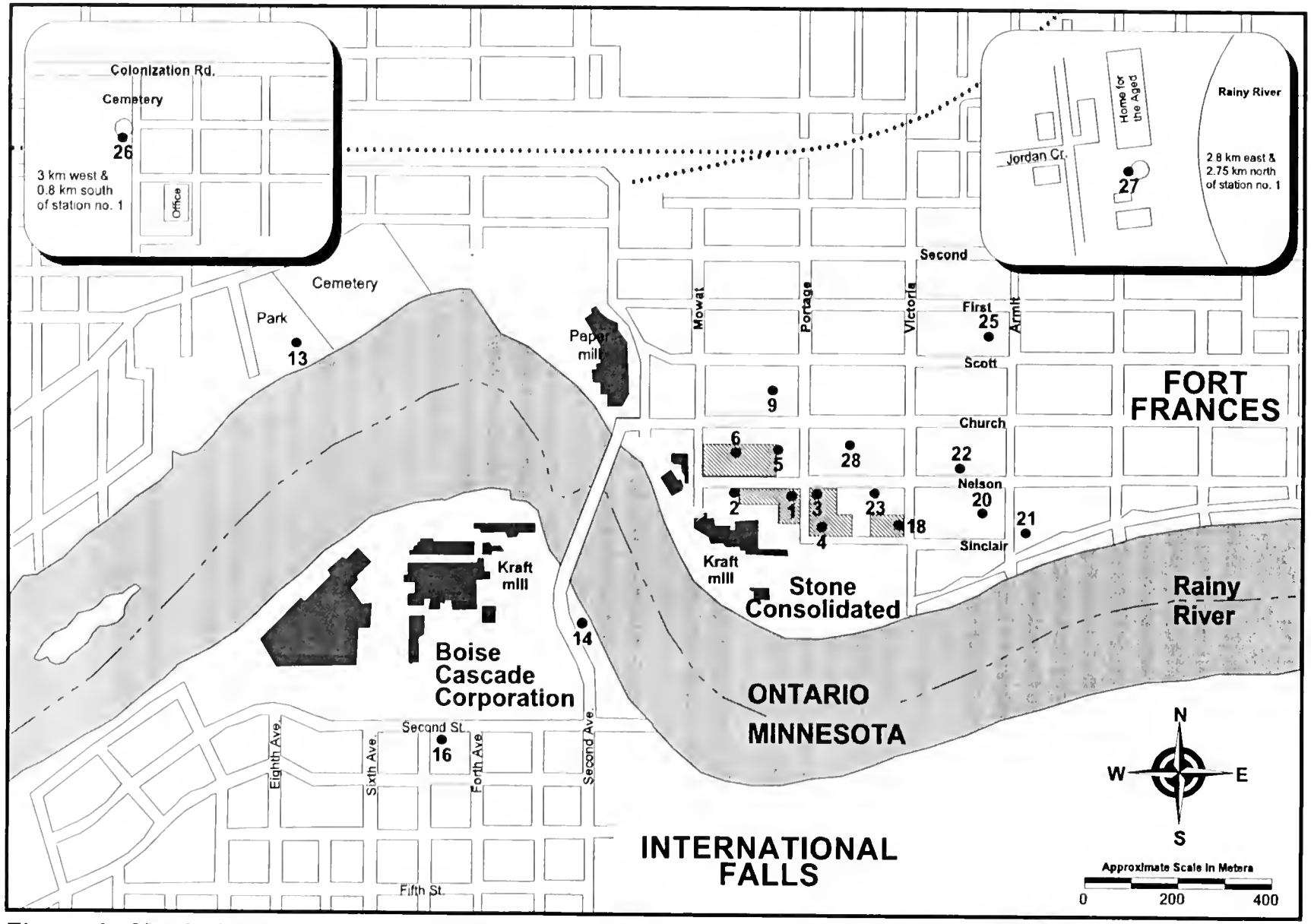


**Figure 1. Manitoba maple sampling sites, Fort Frances, August 13-14, 1996.** Buffer zone

**Figure 2**: Mean Sodium Concentration in Manitoba Maple Foliage - Abitibi Consolidated Fort Frances

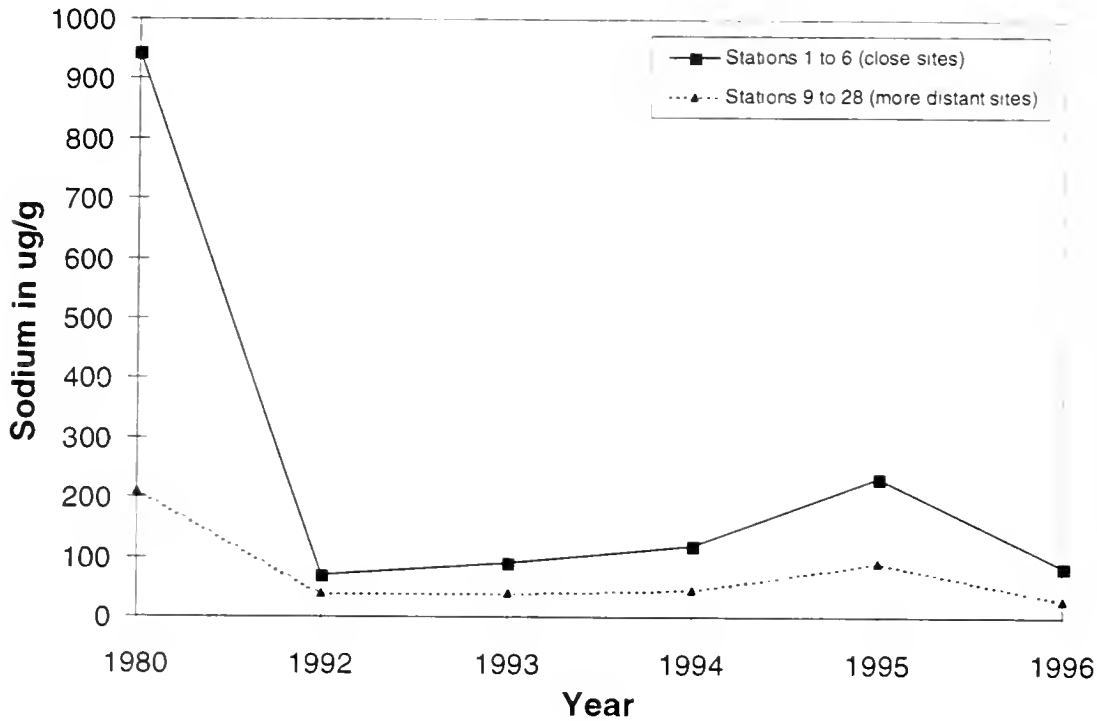


**Figure 3:** Mean Chlorine Concentration in Manitoba Maple Foliage

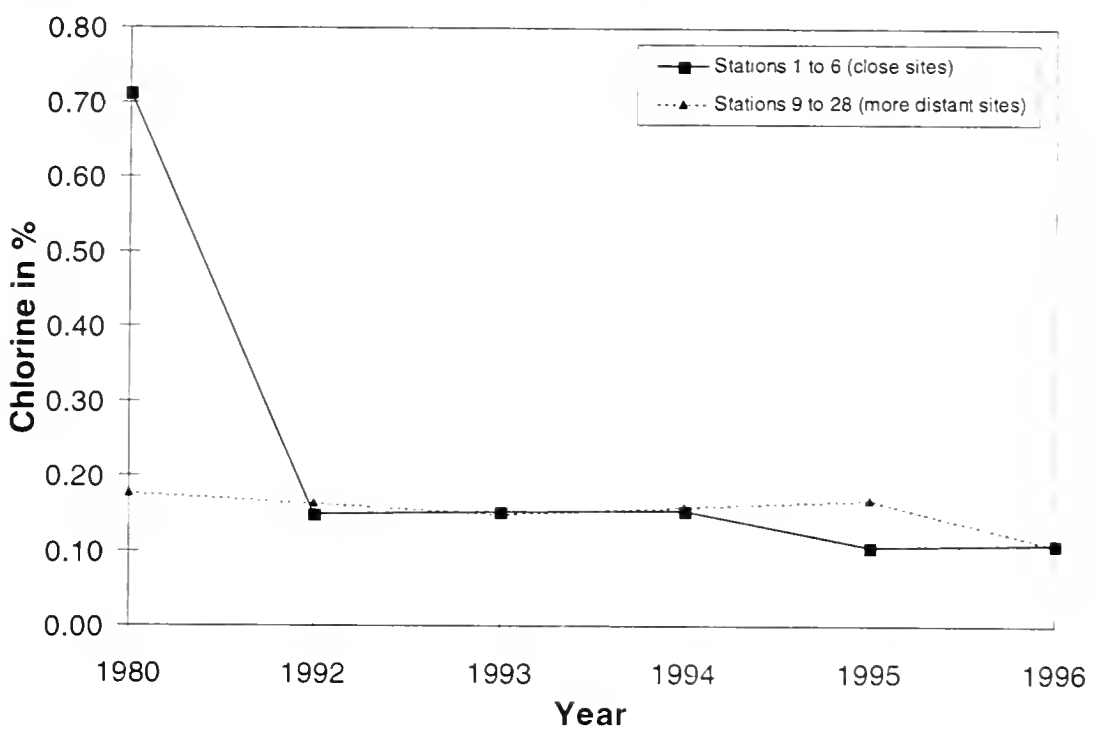

**Table 1:** Mean sodium concentrations in µg/gm dry weight in Manitoba maple foliage collected at 19 sites in the vicinity of Abitibi Consolidated, Fort Frances, 1980, 1992, 1993, 1994, 1995, and August 13-14,1996

| Station | 1980 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| 1 | **1800** | 100 | 95 | 190 | 280 | 150 |
| 2 | **1400** | 60 | 100 | 90 | 330 | 81 |
| 3 | **1200** | 82 | 85 | 110 | 200 | 109 |
| 4 | **620** | 92 | 100 | 170 | 270 | 71 |
| 5 | 260 | 37 | 60 | 95 | 170 | 35 |
| 6 | **390** | 47 | 100 | 60 | 150 | 61 |
| 9 | 150 | 49 | 75 | 65 | 170 | 36 |
| 13 | 83 | 19 | 30 | 30 | 40 | 15 |
| 14 | 53 | 47 | 55 | 50 | 60 | 46 |
| 16 | 73 | 42 | 40 | 50 | 50 | 30 |
| 18 | 120 | 59 | 40 | 65 | 130 | 32 |
| 20 | 250 | 31 | 45 | 30 | 80 | 22 |
| 21 | 250 | 27 | 30 | 36 | 60 | 20 |
| 22 | 140 | 40 | 50 | 35 | 80 | 41 |
| 23 | 280 | 39 | 35 | 40 | 80 | 35 |
| 25 | **410** | 45 | 35 | 45 | 80 | 27 |
| 28 | ND | 37 | 30 | 55 | 90 | 26 |
| 26[c] | 100 | 24 | 20 | 25 | 30 | 17 |
| 27[c] | 100 | 26 | ND | ND | 40 | 15 |
| **ULN** | **350** | **350** | **350** | **350** | **350** | **350** |

[c] - control stations, ND - no data
**ULN** - Phytotoxicoloyg Upper Limit of Normal guideline for sodium in vegetation, see Appendix.
- shaded data exceed ULN guideline.

**Table 2:** Concentration of Chlorine as % dry weight in Manitoba Maple Foliage Collected at 19 Sites in the Vicinity of Abitibi Consolidated, Fort Frances, 1980, 1992, 1993, 1994, and August 13-14,1996

| Station | 1980 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| 1 | 1.17 | 0.10 | 0.07 | 0.10 | 0.05 | 0.05 |
| 2 | 0.81 | 0.19 | 0.20 | 0.23 | 0.18 | 0.15 |
| 3 | 0.87 | 0.19 | 0.15 | 0.15 | 0.12 | 0.18 |
| 4 | 0.71 | 0.12 | 0.27 | 0.15 | 0.11 | 0.12 |
| 5 | 0.35 | 0.15 | 0.11 | 0.17 | 0.12 | 0.11 |
| 6 | 0.36 | 0.14 | 0.11 | 0.12 | 0.05 | 0.04 |
| 9 | 0.22 | 0.20 | 0.32 | 0.16 | 0.32 | 0.13 |
| 13 | ND | 0.03 | 0.02 | 0.02 | 0.03 | 0.01 |
| 14 | 0.08 | 0.06 | 0.04 | 0.08 | 0.05 | 0.09 |
| 16 | 0.53 | 0.16 | 0.15 | 0.39 | 0.42 | 0.40 |
| 18 | 0.21 | 0.31 | 0.10 | 0.24 | 0.22 | 0.11 |
| 20 | 0.10 | 0.16 | 0.11 | 0.14 | 0.16 | 0.09 |
| 21 | 0.15 | 0.09 | 0.13 | 0.18 | 0.08 | 0.07 |
| 22 | 0.13 | 0.20 | 0.16 | 0.12 | 0.12 | 0.06 |
| 23 | 0.26 | 0.22 | 0.19 | 0.25 | 0.15 | 0.16 |
| 25 | 0.17 | 0.11 | 0.14 | 0.15 | 0.30 | 0.14 |
| 28 | ND | 0.15 | 0.17 | 0.17 | 0.13 | 0.19 |
| 26[c] | 0.07 | 0.12 | 0.04 | 0.09 | 0.27 | 0.07 |
| 27[c] | 0.12 | 0.08 | 0.07 | 0.11 | 0.05 | 0.04 |

[c] - control stations, ND - no data
ULN guideline for chloride in vegetation is not available.

| **Table 3:** Visual Observations of Tree Condition and Foliar Injury to Manitoba Maple at 19 Sites in the Vicinity of Abitibi Consolidated, Fort Frances on August 13-14, 1996 | |
|---|---|
| **Station** | **Foliar Injury and Tree Condition** |
| 1 | Trace marginal necrosis on foliage. Mature tree in moderate to poor condition. |
| 2 | Foliage had trace to light marginal necrosis, was mildly chlorotic, and had a red undersuface. Mature tree in poor condition. |
| 3 | Foliage suffering from typical insect damage. Small leaves. Mature tree in poor shape. |
| 4 | Foliage suffering from typical insect damage, and trace tip necrosis. Mature tree in poor shape. |
| 5 | Foliage had trace insect injury and galls. Young approximately 6 m high tree in moderate condition. |
| 6 | Foliage had trace marginal injury on older leaves, and moderate insect damage. Original tree gone, replace with young approximately 6 m high tree in good condition. |
| 9 | Foliage small, suffering from insect damage and likely a viral infection. Mature tree cut down to approximately 4 m high with new suckers at top. |
| 13 | Foliage small and chlorotic, with typical insect damage. Tree in poor condition. |
| 14 | Foliage had trace terminal necrosis, and typical insect damage. Mature tree in moderate condition. |
| 16 | Foliage had typical insect damage. Small sparse tree. |
| 18 | Foliage small and chlorotic, with typical insect damage. Mature tree in poor condition with approximately 70% of crown dead. |
| 20 | Foliage had trace chlorosis, with typical insect damage. Original tree gone, replace with young approximately 6 m high tree 20 m east of original tree. |
| 21 | Foliage had trace chlorosis, with typical insect damage. Mature tree in moderate condition. |
| 22 | Foliage had typical insect damage. Mature tree in good condition. |
| 23 | Foliage had typical insect damage. Mature tree in good condition. |
| 25 | Foliage had typical insect damage. Mature tree in good condition. |
| 28 | Foliage had typical insect damage. Mature tree in good condition. |
| 26 | Foliage had typical insect injury. Mature tree in good condition. |
| 27 | Foliage had trace terminal necrosis and trace insect damage. Mature tree in good condition. |

## Appendix

### Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: *Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section, Air Resources Branch: Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto. ISBN: 0-7729-5143-8.*). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.